(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 363 724 A2**

EUROPEAN PATENT APPLICATION

(12)

(21) Application number: 89117756.0

(51) Int. Cl.5: H01R 13/719

(22) Date of filing: 26.09.89

(30) Priority: 11.10.88 JP 255097/88

(43) Date of publication of application:
18.04.90 Bulletin 90/16

(84) Designated Contracting States:
DE FR GB

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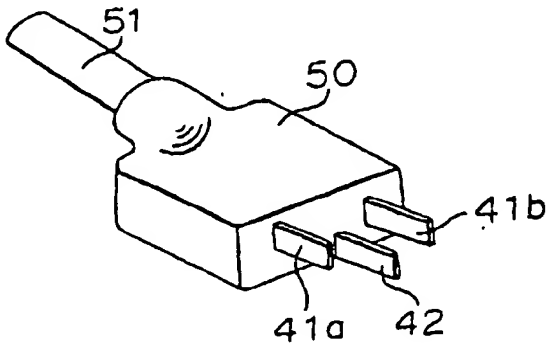
(54) Connector for connecting an electrical circuit.

(57) In a connector for connecting an electrical circuit, one or more conductors (1a,1b,....,1n) are embedded in a magnetic body (2) so as to function as inductance.

FIGURE 7



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CONNECTOR

The present invention is related to a connector (an electrical circuit connecting element), in particular a connector with an electromagnetic interference (hereinbelow, referred to as noise) absorbing means incorporated in it.

Figure 12 is a perspective view showing an example of a conventional ordinally type connector. Figure 13 is a perspective view showing the essential portion wherein the conventional connector is mounted.

In Figure 12, reference numeral 20 designates a conductor for connection. Reference numeral 21 designates an insulating covering (a sleeve) which is used when two electrical circuits are connected as shown in Figure 13.

Aiming at obtaining noise eliminating effect when the circuit connection between terminals 30a and 30b of a circuit pattern is made on a printed circuit boad 42 and the like as shown in Figure 13, the following manners have been utilized:

One manner is to incorporate a noise filter element in a terminal connecting pin 24 to a position adjacent to its leading end, the noise filter element comprising ferrite beads 23 embeded in an insulating member 26 as shown in Figure 14 (First example). The other manner is to incorporate a noise filter instead of the ferrite beads 23, the noise filter comprising a lead-through capacitor 22 and an earth lead 25 as shown in Figure 15 (Second example).

Now, the function/operation on such noise filters will be explained. Signals are sent or received between device circuits through the connecting pin 24. Since a noise component included in the signals is absorbed by the ferrite beads 24 or the lead-through capacity 22, the connecting pin can eventually function as a noise filter.

Figure 16 is a perspective view of a third example of the noise filter element wherein the first and the second example are combined to have the capacity 22 and ferrite beads 23. As shown in Figure 17, the filter noise element of Figure 16 can be connected to the conventional ordinally type of connector of Figure 12 to eliminate conduction noise. In Figures 16 and 17, reference numerals 24, 24a, 24b and 25 indicate terminals.

Figure 18 shows an equivalent circuit of the circuit shown in Figure 17. Specifically, a signal which has been transmitted from the terminal 30a is transmitted to the terminal 24a through the connector 20, and a noise component included in the signal can be eliminated by the capacitor 22 and the equivalent inductance 23a given by the ferrite beads 23. Then, the signal is output from the terminal 30b.

In addition, Figure 19 is a connection diagram showing an example of an AC plug with a noise filter as an application example of such type of connector.

In Figure 19, reference numeral 40 designates an AC cable. Reference numerals 41a, 41b and 42 designate a pair of AC plug pins and a connecting terminal pin, respectively. Reference numeral 43 designates a pair of capacitors. Reference numeral 44 designates a choke coil. The AC plug has such structure that the members 40-44 are molded in an insulating plug body 45 as a connector main body.

A noise which has come from the AC plug pins 41a or 41b is absorbed by an LC filter which is constituted by the choke coil 44 and the capacitors 43, and then is transmitted to the side of the AC cable 40.

Since the conventional manners to eliminate conduction noise requires the structure as mentioned above, a plurality kinds of electrical parts must be utilized in the conventional noise eliminating manners to realize both electrical connection and noise elimination. In particular, the third conventional example (Figures 16 and 17) has disadvantage in terms of a mounting space and economy. The conventional fourth example (Figure 9) in the form of an AC plug has disadvantages in that it is bulky and heavier, and that it is not suitable for mass production. In addition, the conventional manners have disadvantage in that they are little effective to radiation noise.

It is an object of the present invention to eliminate the disadvantages of the conventional devices, and to provide a connector which is capable of making electrical connection between electrical circuits, and of elimiating conduction noise and radiation noise, and which is compact and suitable for mass production.

The foregoing and the other objects of the present invention have been attained by providing a connector for connecting electric circuits, wherein one or more conductors are embeded in a magnetic body so as to function as inductance, independently of a capacitor or together with a capacitor.

Since the present invention has such structure, the present invention can provide a small size and highly efficient connector with a filter circuit element which can absorb kinds of noise by equivalent inductance comprising the conductor or the conductors embeded in the magnetic body, or an LC circuit comprising the combination of the equivalent inductance and the equivalent capacitance comprising a chip capacitor.

In drawings:

Figure 1 is a perspective view showing the structure of a first embodiment of the connector according to the present invention;

Figures 1a and 1b are perspective views showing two examples of shaped conductors for connection which can be utilized in the first embodiment;

Figures 2a, 2b and 2c are perspective views showing three examples of the appearance of the first embodiment;

Figure 3 is an equivalent circuit diagram of the first embodiment;

Figure 4 is a perspective view showing the structure of a second embodiment of the present invention;

Figures 4a and 4b are two examples of shaped conductors for connection which can be utilized in the second embodiment;

Figures 5a and 5b are perspective views showing two examples of the appearance of the second embodiment;

Figure 6 is an equivalent circuit diagram of the second embodiment;

Figure 7 is a perspective view showing the appearance of an AC plug as a third embodiment;

Figure 8 is a vertical cross sectional view of the third embodiment;

Figures 9 and 10 are vertical cross sectional views showing two other examples of the plug as shown in Figure 7;

Figure 11 is a cross sectional view showing a part of the cable of the plug shown in Figure 7;

Figure 12 is a perspective view showing an example of a conventional ordinally type of connector;

Figure 13 is a perspective view showing how the conventional connector is mounted;

Figures 14 through 16 are perspective views showing three examples of conventional noise elliminating filters;

Figure 17 is a perspective view showing how the filter of Figure 16 is mounted;

Figure 18 is an equivalent circuit diagram of the electrical circuit of Figure 16; and

Figure 19 is a connection diagram showing an application example of an conventional AC plug.

Now, the present invention will be described in detail with reference to referred embodiments illustrated in the accompanying drawings.

(First Embodiment)

Figure 1 is a perspective view showing the structure of the first embodiment of the connector according to the present invention.

1) Structure

In Figure 1, reference numerals 1a, 1b,...1n designate one or more shaped conductors for connection which are processed to take a half-round form (to form a coil having half turn). The half-round portion formations are preferably provided or arranged in alternate vertically opposite directions (the convex shape and the concave shape are alternately repeated) to avoid mutual interference between adjacent conductors. The shaped conductors are embeded in a magnetic body 2 which is prepared by densely sintering or shaping e.g. ferrite material (in a molded form or compound form).

The shaped conductor 1a for connection can be shaped to have a substantially round form (one turn) as shown in Figure 1b instead of having the half-round shape (half turn) as shown in Figure 1a. The number of the turn can be plural. The shape of the turn can be linear or rectangular. Such shaped portions can project in one side direction instead of alternately extending in vertically opposite directions.

Figures 2a and 2b are perspective views showing the appearance of two examples of DIP (Dual-in-line-package) of an ordina y IC (integrated circuit) in accordance with the first embodiment of Figure 1.

Figure 2c is a perspective view showing the appearance wherein the magnetic body with the conductors embeded in it is covered with a metallic case as needed. The presence of the metallic case can offer an electrostatic shielding effect.

2) Operation

Figure 3 is an electrical equivalent circuit diagram of the first embodiment.

Electric signals are given to each one end of the conductors 1a, 1b, ...1n, and are output from each other end. The dc components in the signals can be transmitted through the conductors without being substantial attenuated. High frequency components in the signals can be prevented by equivalent inductances 2a, 2b, ...2n which comprise the conductors 1a, 1b ...1n and the magnetic body 2, respectively, thereby allowing good noise filter effect to be realized.

(Second Embodiment)

1) Structure.

Figure 4 is a perspective view showing the structure of the second embodiment. The second

embodiment is characterized in that one or more shaped conductors 1a, 1b, ...1n for connection have their one ends connected to chip capacitors 9a, 9b, ...9n, that the capacitors have their other ends connected to terminals 10a, 10b, ...10n for connection, and that the conductors, the chip capacitors and the terminals are embeded in a sinterred or shaped magnetic body 2.

Figures 4a and 4b are perspective view showing the appearance of two examples of the shaped conductor in accordance with the second embodiment.

Figures 5a and 5b are perspective views showing the appearance of two examples of the appearance in accordance with the second embodiment. In Figure 5b, the magnetic body 2 can be covered with a metallic case 12 as needed to add electrostatic shielding effect to the noise filter effect.

2) Operation

Figure 6 is an electrical equivalent circuit diagram of the second embodiment.

Since the conductors 1a, ...1n are sealed in the magnetic body 2, they can function as inductors as shown in an equivalent inductance 11 of Figure 6. The conductors also form LC filters together with the chip capacitors 9a, 9b ...9n, each of which is connected to one end of the equivalent inductance.

In the equivalent circuit of Figure 6, a signal which has been input from a terminal 12a has its noise component absorbed by the equivalent inductance 11 and the capacitor (capacitance 9, and is output from the other terminal 12b. In this way, a high frequency noise component can be eliminated. The other end 10a of the equivalent capacitance 9 is grounded in terms of an ac component. Since the conductors 1a, ...1n are sealed in the magnetic body 2, the connector according to the present invention can absorb both conduction noise and radiation noise.

(Third Embodiment)

Figure 7 is a perspective view showing the appearance of an AC plug with noise filter as the third embodiment, the AC plug being one of application examples of the connector wherein the principle of the present invention is utilized. Figure 8 is a vertical cross sectional view showing the AC plug, the same reference numerals indicating constituent elements similar or corresponding to those of the conventional device of Figure 19.

1) Structure

Reference numerals 41a and 41b indicate a pair of AC plug pins. Reference numeral 42 designates a ground terminal pin. Reference numeral 50 designates a shaped plug body which is molded from magnetic compound. Reference numeral 51 designates a cable with ground, which includes wires 52, and a ground wire in its inside. These constituent elements have their end portions molded in or sealed by the magnetic compound 50 as shown in Figure 8.

2) Operation

Noise components which have flowed in from the plug pins 41a and 41b can be attenuated by a choke coil component since the pins 41a and 42b, and the wires 52 in the cable 51 are embeded in the magnetic compound 50 to have an inductance component, thereby functioning as a choke coil. As a result, the present invention can provide a small size and lightweight AC plug.

3) Other Embodiments

Explanation on the embodiments as stated earlier have been made on a case wherein the cable 51 is molded and sealed by the magnetic compound 50. As shown in vertical cross sectional views of Figures 9 and 10, a pair of capacitors 54 can be arranged, or a pair of coils 55 can be added to the paired capacitors 54, the paired capacitor 55 are embeded in the magnetic compound 50, thereby allowing noise eliminating effect to be remarkably improved.

As shown in a fragmentary sectional view showing a cable of Figure 11, insulating coating 56 of the cable 51 can be made from e.g. ferrite compound like the plug main body 50, thereby to give noise absorbing effect to the entirety of the cable.

Although explanation on the embodiments as stated earlier have been made in the case of a fixed connector and the application example of the AC plug, the present invention is also applicable to a disconnector or other switching devices to obtain effect similar to the embodiments as explained above.

Claims

1. A connector for connecting an electrical circuit, characterized in that one or more conductors (1a,1b,....,1n) are embedded in a magnetic body (2) so as to function as inductance.

2. A connector according to claim 1, char-

acterized in that at least one conductor (1a,1b,...,1n) has its end provided with a capacitor (9a,9b,...,9n).

3. A connector according to claims 1 or 2, characterized in that a main body (50) of the connector is constituted by a magnetic compound to function as an AC plug.

FIGURE 1

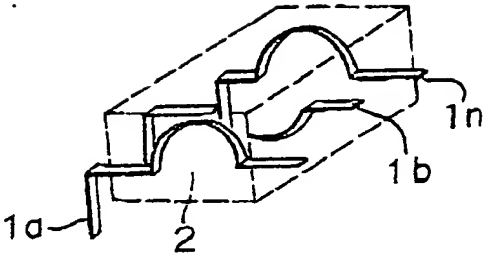

FIGURE 1a

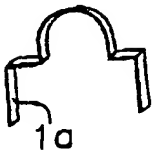

FIGURE 1b

FIGURE 2a

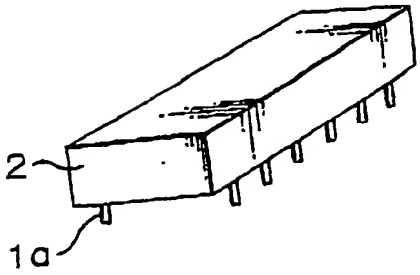

FIGURE 2b

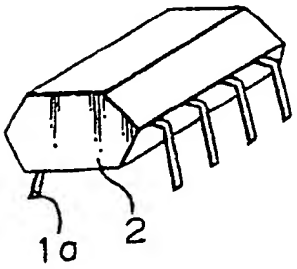

FIGURE 2c

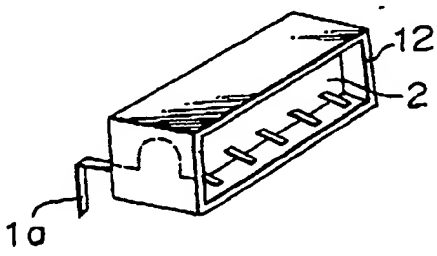

FIGURE 3

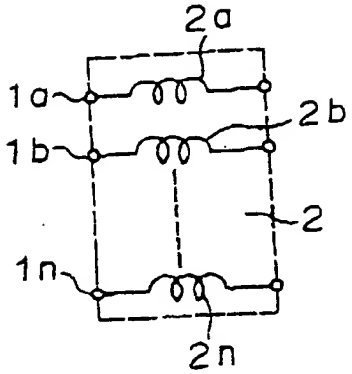

FIGURE 4

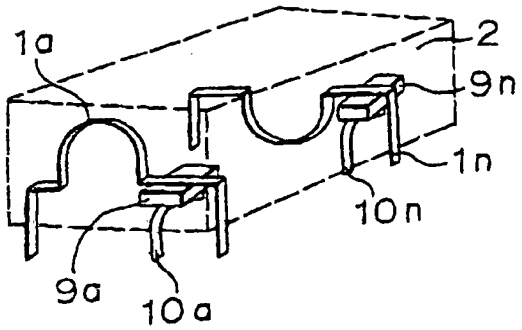

FIGURE 4a

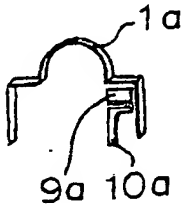

FIGURE 4b

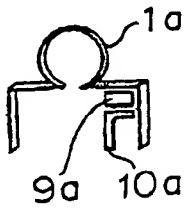

FIGURE 5a

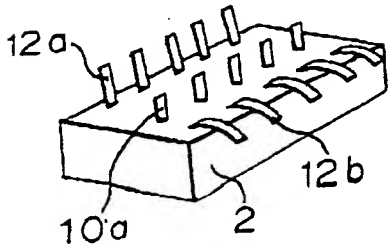

FIGURE 5b

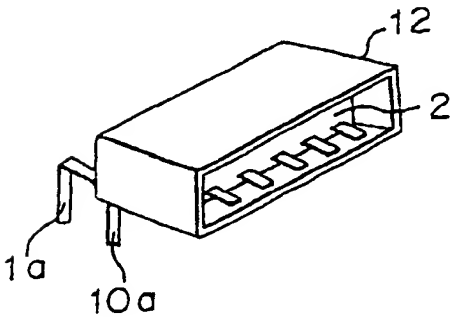

FIGURE 6

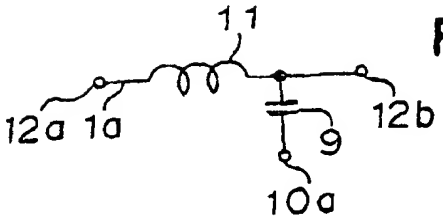

FIGURE 7

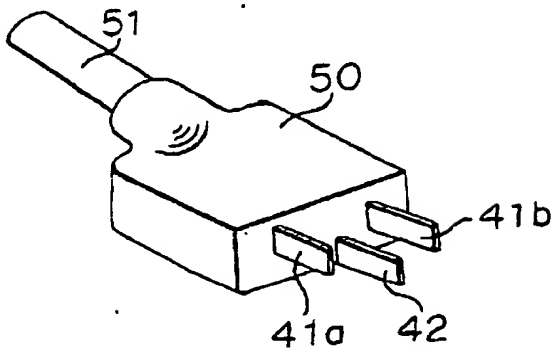

FIGURE 8

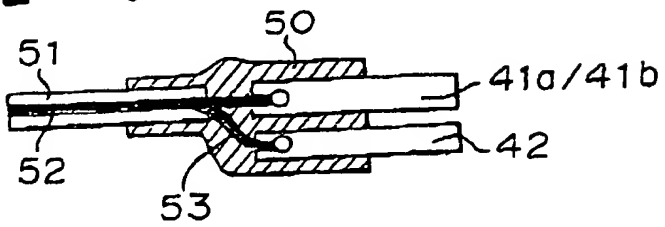

FIGURE 9

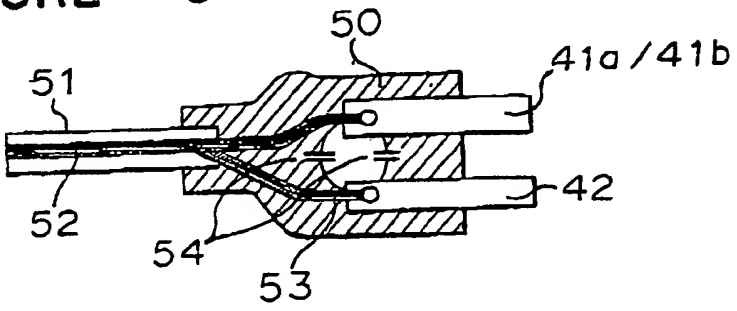

FIGURE 10

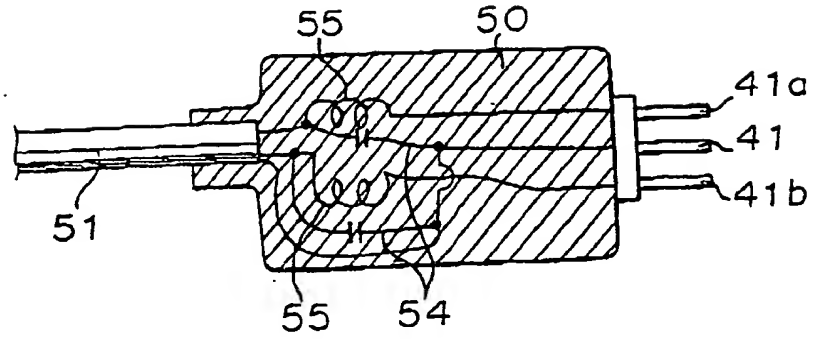

FIGURE 11

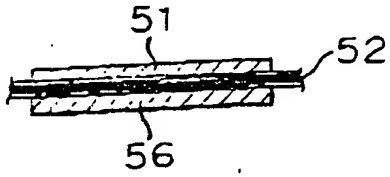

FIGURE 12

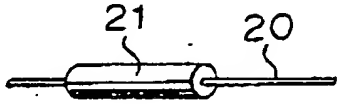

FIGURE 13

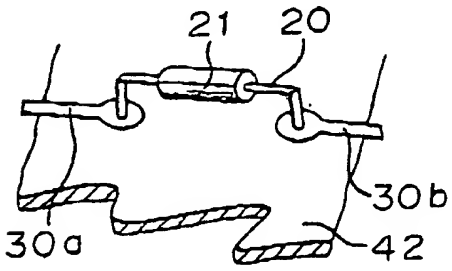

FIGURE 14

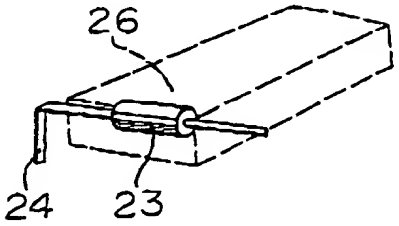

FIGURE 15

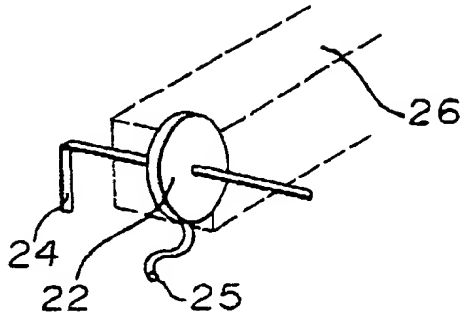

FIGURE 16

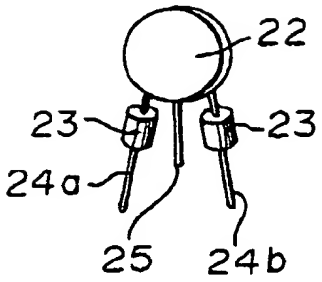

FIGURE 17

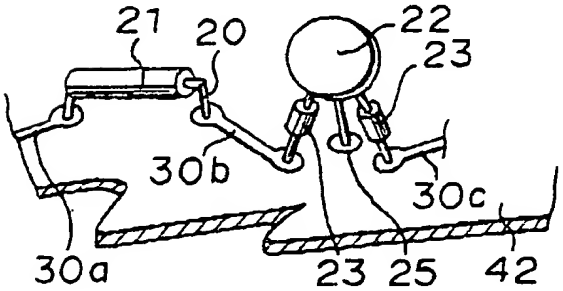

FIGURE 18

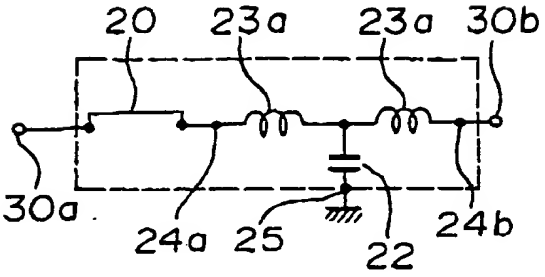

FIGURE 19